7.1 Graph Exponential Growth Functions

Before You graphed polynomial and radical functions.
Now You will graph and use exponential growth functions.
Why? So you can model sports equipment costs, as in Ex. 40.

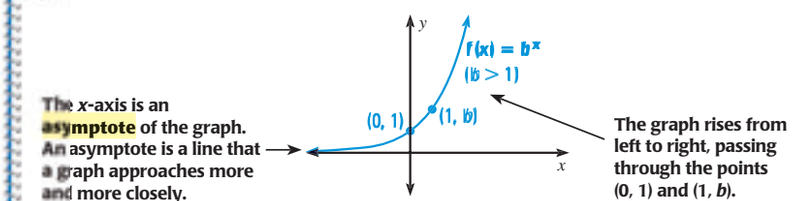
Key Vocabulary
- **exponential function**
- **exponential growth function**
- **growth factor**
- **asymptote**

An **exponential function** has the form $y = ab^x$ where $a \neq 0$ and the base b is a positive number other than 1. If $a > 0$ and $b > 1$, then the function $y = ab^x$ is an **exponential growth function**, and b is called the **growth factor**. The simplest type of exponential growth function has the form $y = b^x$.

KEY CONCEPT *For Your Notebook*

Parent Function for Exponential Growth Functions

The function $f(x) = b^x$, where $b > 1$, is the parent function for the family of exponential growth functions with base b. The general shape of the graph of $f(x) = b^x$ is shown below.



The domain of $f(x) = b^x$ is all real numbers. The range is $y > 0$.

EXAMPLE 1 Graph $y = b^x$ for $b > 1$

Graph $y = 2^x$.

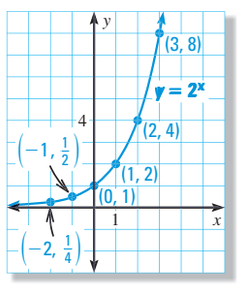
Solution

STEP 1 **Make** a table of values.

x	-2	-1	0	1	2	3
y	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8

STEP 2 **Plot** the points from the table.

STEP 3 **Draw**, from *left* to *right*, a smooth curve that begins just above the x-axis, passes through the plotted points, and moves up to the right.



1 PLAN AND PREPARE

Warm-Up Exercises

Transparency Available

Evaluate the expression without using a calculator.

1. 5^{-2} $\frac{1}{25}$
2. $8^{2/3}$ 4
3. $-3 \cdot 4^{3/2}$ -24
4. State the domain and range of the function $y = -(x - 2)^2 + 3$. **domain: all real numbers; range: $y \leq 3$**

Notetaking Guide

Transparency Available

Promotes interactive learning and notetaking skills, pp. 185–188.

Pacing

Basic: 1 day
Average: 1 day
Advanced: 1 day
Block: 0.5 block with 7.2
• See Teaching Guide/Lesson Plan.

2 FOCUS AND MOTIVATE

Essential Question

Big Idea 1, p. 477

What does the graph of an exponential growth function look like?

Tell students they will learn how to answer this question by graphing a variety of exponential growth functions.

NCTM STANDARDS

Standard 3: Apply transformations to math situations

Standard 10: Use representations to model phenomena

Resource Planning Guide

Chapter Resource Book
- Teaching Guide/Lesson Plan (pp. 3–4)
- Practice levels A, B, C (pp. 6–8)
- Study Guide (p. 9–10)
- Catch-up for Absent Students (p. 11)
- Problem Solving Workshop (p. 12)
- Challenge (p. 13)

Workbooks
- Notetaking Guide (pp. 185–188)
- Practice Workbook (pp. 108–109)

Teaching Options
- **Power Presentations CD-ROM** provides dynamic electronic teaching resources for the classroom.
- **Activity Generator CD-ROM** provides editable activities for all ability levels.

Interactive Technology
- Easy Planner
- Power Presentations CD-ROM
- Activity Generator CD-ROM
- Animated Algebra
- Test Generator CD-ROM
- Online Quiz
- eWorkbook
- eEdition
- @HomeTutor

Resources for English Learners
- Quick Reference for English Learners
- Spanish Study Guide
- Multi-Language Visual Glossary
- Student Resources in Spanish

See also the Algebra 2 Toolkit for more strategies for meeting individual needs.

The graph of a function $y = ab^x$ is a vertical stretch or shrink of the graph of $y = b^x$. The y-intercept of the graph of $y = ab^x$ occurs at $(0, a)$ rather than $(0, 1)$.

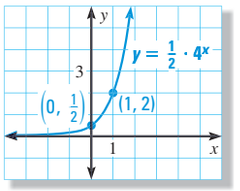
EXAMPLE 2 Graph $y = ab^x$ for $b > 1$

Graph the function.

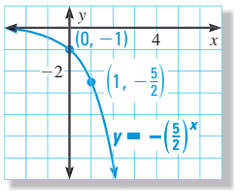
a. $y = \frac{1}{2} \cdot 4^x$ **b.** $y = -\left(\frac{5}{2}\right)^x$

Solution

a. Plot $\left(0, \frac{1}{2}\right)$ and $(1, 2)$. Then, from *left* to *right*, draw a curve that begins just above the x-axis, passes through the two points, and moves up to the right.



b. Plot $(0, -1)$ and $\left(1, -\frac{5}{2}\right)$. Then, from *left* to *right*, draw a curve that begins just below the x-axis, passes through the two points, and moves down to the right.



CLASSIFY FUNCTIONS Note that the function in part (b) of Example 2 is not an exponential growth function because $a = -1 < 0$.

TRANSLATIONS To graph a function of the form $y = ab^{x-h} + k$, begin by sketching the graph of $y = ab^x$. Then translate the graph horizontally by h units and vertically by k units.

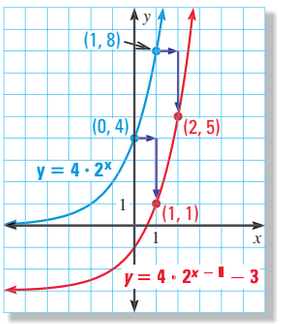
EXAMPLE 3 Graph $y = ab^{x-h} + k$ for $b > 1$

Graph $y = 4 \cdot 2^{x-1} - 3$. State the domain and range.

Solution

Begin by sketching the graph of $y = 4 \cdot 2^x$, which passes through $(0, 4)$ and $(1, 8)$. Then translate the graph right 1 unit and down 3 units to obtain the graph of $y = 4 \cdot 2^{x-1} - 3$.

The graph's asymptote is the line $y = -3$. The domain is all real numbers, and the range is $y > -3$.



GUIDED PRACTICE for Examples 1, 2, and 3

Graph the function. State the domain and range. 1–3. See margin.

1. $y = 4^x$ **2.** $y = \frac{1}{2} \cdot 3^x$ **3.** $f(x) = 3^{x+1} + 2$

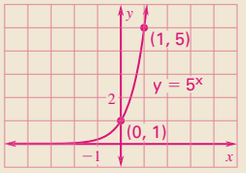
Motivating the Lesson

If you know the current tuition at the college you want to attend and the percent by which tuition has been increasing annually, you can use an exponential growth model to estimate the tuition for the year in which you will start college.

3 TEACH

Extra Example 1

Graph $y = 5^x$.

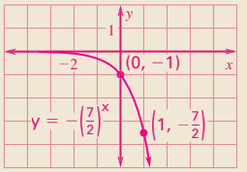


Extra Example 2

Graph the function.

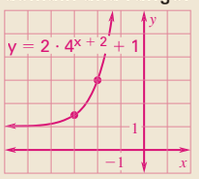
a. $y = \left(\frac{1}{3}\right) \cdot 3^x$

b. $y = -\left(\frac{7}{2}\right)^x$



Extra Example 3

Graph $y = 2 \cdot 4^{x+2} + 1$. State the domain and range.



domain: all real numbers; range: $y > 1$

1–3. See Additional Answers beginning on p. AA1.